Durability of open popliteal artery aneurysm repair

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Objective: **The objective of this study was to analyze our long-term results after open surgery for popliteal artery aneurysm.**
Methods: **Records of patients who received surgery between 1998 and 2010 were retrieved from a computerized database and analyzed retrospectively. End points of the study were perioperative mortality and morbidity and patency and limb salvage rate.**
Results: **Two hundred and six popliteal aneurysms (median diameter, 30 mm; interquartile range, 18 mm) were treated (161 elective, 45 emergent) in 154 patients (mean age, 67 ± 11 years) using vein grafts (82%) via the medial approach (92%). Above-knee popliteal artery (45%) and below-knee popliteal artery (65%) were the predominant inflow and outflow vessels. The overall surgical mortality was 2% (2% for elective and 3% for emergent procedures; P = not significant). Primary, assisted primary, and secondary patency rates were 88.1% (73.5%), 92.1% (84.3%), and 96.5% (89.8%) at 5 (at 10) years, respectively, with no significant difference between elective and emergent surgeries. Limb salvage rate was significantly reduced in the emergent group vs the elective group with 91.1% vs 98.6% at 5 and 10 years (P = .0049). The rate of freedom from any reintervention was 84.3% at 5 and 69.8% at 10 years, respectively.**
Conclusions: **Open surgery for popliteal artery aneurysm is marked by low perioperative mortality and morbidity and provides excellent long-term results. (J Vasc Surg 2014;60:951-7.)**

Although uncommon in the general population, with an estimated incidence of less than 0.1%, popliteal artery aneurysms are considered to be the most common peripheral aneurysms (70%).[1] Most popliteal aneurysms are asymptomatic, however, in 20%, presentation is acute and limb loss is imminent because of aneurysm thrombosis or peripheral embolism.[2]

First described >4000 years ago, surgical treatment of popliteal aneurysms has made a considerable evolution. Initial attempts of proximal and distal ligation were described in the early 18th century ("Antyllus technique") but were endowed with a considerable "failure rate." They were further refined in the famous surgery performed by John Hunter in 1785 with proximal ligation distant from the neck ("Hunterian ligation"). After attempts of local reconstructive procedures (restorative aneurysmorraphy by Matas in 1903), milestones of surgical ingenuity that mark the advent of the modern era were the technique of aneurysm exclusion and short interposition grafting using reversed saphenous vein introduced by Erich Lexer in 1912, and the proximal and distal ligation combined with vein bypass via the medial approach first described by Edwards in 1969.[3] Since then, multiple studies were published on the outcome after open surgical treatment and currently, limb loss rates of 0% to 1% can be anticipated in asymptomatic patients, and in patients presenting with acute symptoms, a limb loss rate of 3% to 30% has been observed.[2]

However, only a few studies exist that involve more than 100 cases, and long-term data extending beyond 5 years are equally sparse. This is of great interest, because the well established concept of open surgical treatment is becoming increasingly challenged by the endovascular therapy of popliteal aneurysms that was introduced in 1994.[4]

Therefore, the aim of the study was to review and share our results of open surgery for popliteal artery aneurysm with special attention to long-term outcome.

METHODS

From the computerized database of the Division of Vascular Surgery, records of 154 consecutive patients who received surgery for popliteal artery aneurysm in the period between January 1998 and January 2010 (total number of infrainguinal reconstructions: 2758) were retrieved and complete patient charts were analyzed retrospectively. All patients had signed informed consent for the procedure, and approval of the study by the local ethics committee was waived due to the retrospective design of the study.

The patient demographic characteristics are given in Table I. Patient risk factors were defined as follows: hypertension (controlled with ≥one drug), diabetes (oral antidiabetic medication and/or insulin therapy), nicotine abuse (active smoking of ≥one pack per day), hyperlipidemia (controlled with ≥one drug), coronary artery disease (history of ≥one vessel disease), renal insufficiency (serum creatinine ≥2 mg/dL), end-stage renal disease (permanent hemodialysis).

Preoperative imaging consisted of either high-resolution computed tomography angiography, magnetic resonance angiography, or fine-needle digital subtraction

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Table I. Patient characteristics (N = 154)

Characteristic	*Value*
Mean age ± SD (range), years	67 ± 11 (40-95)
Sex (male/female)	148/6 (96/4)
Hypertension	118 (77)
Nicotine abuse	74 (48)
Hyperlipidemia	71 (46)
Diabetes mellitus	23 (15)
Coronary artery disease [CABG]	52 [21] (34 [14])
Renal insufficiency (end-stage renal disease)	22 [11] (14 [7])
ASA class III/IV	70/65 (46/42)

ASA, American Society of Anesthesiologists; *CABG,* coronary artery bypass grafting; *SD,* standard deviation.
Data are presented as number (%) except where otherwise noted.

Table II. Indication and surgical details (N = 206 surgeries)

Indication	*No. (%)*
Asymptomatic	117 (57)
Disabling claudication	44 (21)
Thrombosed aneurysm	41 (20)
Ruptured aneurysm	4 (2)
Site of proximal anastomosis	
Femoral [CFA/DFA]	41 [33/8] (20 [16/4])
Femoral, SFA	72 (35)
Popliteal, SI	93 (45)
Site of distal anastomosis	
Popliteal, SIII	134 (65)
Tibial: tibioperoneal trunk/anterior/posterior/peroneal	70 [21/25/10/14] (34 [10/12/5/7])
Pedal, dorsal	2 (1)
Sequential anastomosis, popliteal/tibial	19 [4/15] (9 [2/7])
Bypass graft	
GSV	165 (80)
Arm vein	3 (2)
Prosthetic (HUV, Omniflow II)	28 (14)
Composite (prosthetic and GSV) graft	10 (5)
Approach	
Medial/dorsal	190/16 (92/8)

CFA, Common femoral artery; *DFA,* deep femoral artery; *GSV,* greater saphenous vein; *HUV,* human umbilical vein (Bio Vascular Inc, St. Paul, Minn); *SFA,* superficial femoral artery; *SI,* popliteal artery segment I; *SIII,* popliteal artery segment III.
The Omniflow II is manufactured by Bio Nova International Pty Ltd, North Melbourne, Australia.

angiography in selected cases (using carbon dioxide for patients with renal impairment). Quality and putative length of venous conduit was assessed using preoperative vein-mapping using duplex ultrasound.

The surgeries were performed using general anaesthesia and the surgical details are listed in Table II. For nonreversed grafts, side branches were ligated and valves were destroyed using the "Mills" valvulotome (Teleflex Medical, Research Triangle Park, NC). For in situ grafts, destruction of vein valves was accomplished using a distally inserted catheter-mounted valvulotome (LeMaitre, Vascutech, Burlington, Mass). After completion of the proximal anastomosis, vein valves were cut and major side branches were identified and ligated using a flow probe (CM 4008; Cardiomed, Oslo, Norway). After demonstration of a sufficient distal pulse, the distal anastomosis was completed. Intraoperative quality control was performed using transit time flow measurement (Cardiomed) and digital subtraction angiography in selected cases. Grafts were routinely anastomosed in an end-to-end fashion and in cases of perfused aneurysm, selective ligation of the adjacent popliteal artery was performed. In selected cases (ie, thrombosed aneurysm) an end-to-side anastomosis was used. In case of absence or insufficient length of vein graft, we used prosthetic biografts using either the human umbilical vein (HUV; Bio Vascular Inc, St. Paul, Minn) or the Omniflow II biograft (Bio Nova International Pty Ltd, North Melbourne, Australia). For selective intraoperative intra-arterial lysis of tibial outflow vessels in acutely thrombosed popliteal aneurysms, 100,000 IU urokinase was applied per patient.

All patients received intravenous anticoagulation (unfractionated heparin) following a staged application scheme in the first three postoperative days of 500 IU unfractionated heparin on the day of surgery, 800 IU unfractionated heparin at postoperative day 1, and 1000 IU of unfractionated heparin at day 2. At day 4, activated partial thromboplastin time was adjusted to 60 to 70 seconds. Intravenous anticoagulation was replaced by oral anticoagulation (target international normalized ratio, 2.5-3.0) before discharge in the absence of contraindications.[5]

The postoperative imaging protocol consisted of duplex ultrasound for all reconstructions and computed tomography scan or magnetic resonance angiography in selected cases. Patients were entered into a routine follow-up program with clinical and duplex ultrasound examinations at 1, 3, and 12 months with annual repetitions thereafter (Division of Angiology), complemented with computed tomography angiography/magnetic resonance angiography in selected cases (graft stenoses/aneurysmal dilatation). In addition, for the purpose of this study, survival and limb salvage information was retrieved by contacting living patients (phone interview) or their general physician (deceased patients) for all cases.

For patency analysis, the latest date of objective proof of patency (duplex ultrasound) was used and patency rates were calculated using the Kaplan-Meier method using the following definitions: a graft was considered to have primary patency if it had uninterrupted patency with no procedure performed on it. If graft patency could successfully be restored after occlusion, it was considered to have secondary patency. For assisted primary patency, grafts were considered when patency was never lost but maintained using prophylactic intervention such as patch, percutaneous intervention, and partial graft replacement (retaining most of the graft and at least one anastomosis in continuity). Placement of an entire new graft in cases of thrombosed bypass ("redo operation") was not considered for secondary patency. For the analysis of freedom from

any reintervention, the percentage of patients who had primarily patent grafts with no secondary graft procedures (thrombectomy/service procedure) or amputations was calculated. Statistical analysis (Kaplan-Meier) was performed using GraphPad Prism 3 (Graphpad Software Inc, San Diego, Calif) using a *t*-test for categorical and Mann-Whitney test for continuous variables; a P value of $<.05$ was considered statistically significant. For Kaplan-Meier analysis, curves were terminated when the number of subjects at risk was <10% of baseline or standard error of the mean exceeded 10%.

RESULTS

During a 12-year period (1998-2010), 154 patients (96% men) received surgery for a popliteal artery aneurysm (Table I). Forty-five surgeries were performed as an emergency procedure because of acutely thrombosed aneurysms with critical limb ischemia or ruptured aneurysms. Most (88%) of the patients had considerable comorbidity (American Society of Anesthesiologists class III and IV). We observed a rate of 31% bilateral disease (47 patients) and a coincidence with abdominal aortic aneurysms in 32% (49 patients). Additionally, five patients had redo operations (placement of an entire new graft) on the same limb; one patient had two redo operations, and four patients had one redo operation.

This led to a total number of 206 surgeries (Table II). The median diameter of the aneurysms was 30 (interquartile range, 18) mm with a range between 12 mm and 85 mm and most of the surgeries (57%) were performed for asymptomatic aneurysms. A disabling claudication was present in 21% of the patients because of occlusion of tibial vessels as a consequence of previous distal embolization or concomitant atherosclerotic occlusive disease. The mean surgery time for all procedures was 205 ± 70 minutes, with emergency procedures being significantly longer than elective surgeries (228 ± 74 minutes vs 192 ± 35 minutes; $P = .0131$). The predominant inflow and outflow vessels were popliteal artery segment I (45%) and III (65%), respectively. However, the actual number of short interposition grafts (popliteal artery segments I-III) was only 70 (34%) and the most of the grafts had either more proximal inflow (superficial femoral artery, common femoral artery) or more distal outflow (tibial). The autologous vein served as a conduit in most cases (82%). In case of insufficient vein length (18%), it was our policy to use biological grafts. Here, the HUV (Bio Vascular Inc) graft was used until 2006, and since 2006 it was replaced with the Omniflow II (Bio Nova International Pty Ltd) biograft because the HUV graft had been withdrawn from the market. Vein grafts were oriented in the transposed, nonreversed fashion in most cases (63%), reversed grafts were used in 12%, and in situ grafts were placed in 25% (predominantly for long femorotibial grafts).

The early results are given in Table III. Three patients (two in the elective and one in the emergency group) died within 30 days, leading to an overall perioperative mortality rate of 2%. In the elective group, one patient died at the age of 89 years due to myocardial infarction at postoperative day 8 and one patient with chronic pulmonary hypertension and a history of pulmonary thromben-darterectomy for recurrent pulmonary embolism died of right ventricular failure at postoperative day 16. In the emergency group, one patient died of myocardial infarction at postoperative day 5.

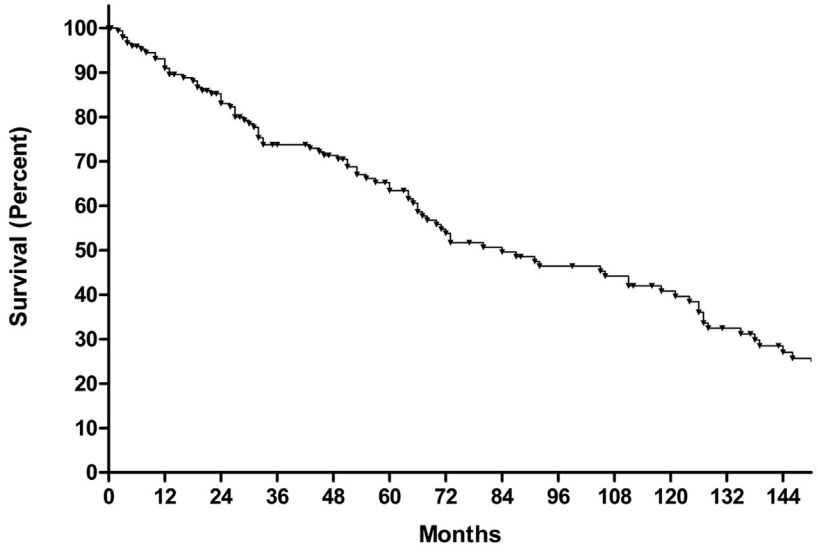
Table III. Early results (30 days)

Result	*Overall, No. (%)*	*Elective, No. (%)*	*Emergent, No. (%)*	P
Mortality	3 (2)	2 (2)	1 (3)	.8566
Graft occlusion	9 (4)	5 (3)	4 (9)	.0942
Thrombectomy	8 (4)	5 (3)	3 (7)	.2766
Hematoma	16 (8)	11 (7)	5 (11)	.3455
Fasciotomy	11 (5)	4 (3)	7 (16)	.0005
Major amputation	4 (2)	0 (0)	4 (9)	.0002

Nine early graft occlusions were noted with eight grafts that could be successfully treated using thrombectomy. In one patient of the emergency group with extensive tissue necrosis due to extended preoperative ischemia, no redo operation for graft occlusion was attempted; instead, an above-knee amputation was performed. Three graft occlusions occurred in prosthetic grafts (8%), and six in vein grafts (4%). In seven patients of the emergency group and four patients of the elective group, fasciotomy was performed. In the latter cases, development of compartment syndrome was due to hyperperfusion after two proximally occluded tibial arteries were revascularized using sequential bypass. Fasciotomy wounds were either treated with secondary closure (n = 3) or skin grafting (n = 6). Four major amputations were necessary in the early postoperative period: in addition to the amputation already mentioned, three above-knee amputations were performed despite patent bypass grafts due to extensive soft-tissue damage.

Intraoperative selective thrombectomy of tibial outflow vessels and selective lysis of vessels in cases in which a descending thrombosis into tibial arteries had occurred was performed in 16 patients (36%) of the emergency group.

The late results in this study showed a median follow-up of 137 (range, 1-185) months with an overall survival rate of 63.5% at 5 years and 40.8% at 10 years and no significant difference between elective and emergent surgeries ($P = .7636$; Fig 1). Twelve graft occlusions were noted at postoperative intervals between 2 and 127 months. For all graft occlusions (early and late), no significant difference was noted in primary patency of vein vs prosthetic grafts ($P = .0678$). Three graft occlusions were treated using thrombectomy, one patient (femoropopliteal [segment III] bypass) received thrombectomy and distal graft extension (to the anterior tibial artery), and in three cases, the occluded graft was replaced by a new graft. One patient required below-knee amputation and in four cases, graft occlusion was managed conservatively. The resulting primary and secondary patency rates were 88.1% and 96.5% at 5 years and 73.5% and 89.8% at 10 years (Fig 2). When primary and secondary patency rates were separately



Survival	Months	0	12	24	36	48	60	72	84	96	108	120	132	144
	%	100	90.9	83	73.8	71.3	63.5	53.8	49.6	46.4	44.2	40.8	32.4	27.1
	No. at risk	154	131	116	93	87	72	55	48	44	41	36	27	21
	SEM		2.3	2.8	3.4	3.6	4.1	4.6	4.7	4.8	4.9	5.1	5.4	5.9

Fig 1. Kaplan-Meier analysis of overall patient survival. In subgroup analysis, survival in the elective and emergent group was not significantly different ($P = .7636$). *SEM,* Standard error of the mean.

analyzed for elective and emergent surgeries, no statistically significant difference was noted ($P = .1031$ and .2997 for primary and secondary patency rates, respectively). Secondary procedures encompassed patch plasty (n = 5), proximal (n = 8) and distal (n = 2) graft replacement (maximum one-third of graft length), and percutaneous angioplasty (n = 1). Six of the eight proximal grafts replacements were necessary because of aneurysmal degeneration of a vein graft. The corresponding assisted primary patency rate was 92.1% at 5 years and 84.3% at 10 years (Fig 2) with no statistical significance between elective and emergent surgeries ($P = .2259$). Two amputations at 9 months postoperatively were necessary, one above the knee in a patient with prosthetic graft infection (HUV graft; Bio Vascular Inc) and a below-knee amputation because of graft occlusion (mentioned previously). The overall limb salvage rate was 96.9% at 5 and 10 years, however, because of the significant difference in perioperative amputation rate, limb salvage was significantly reduced in the emergency group with a rate of 91.1% at 5 and 10 years compared with the elective group (98.6%; $P = .0049$).

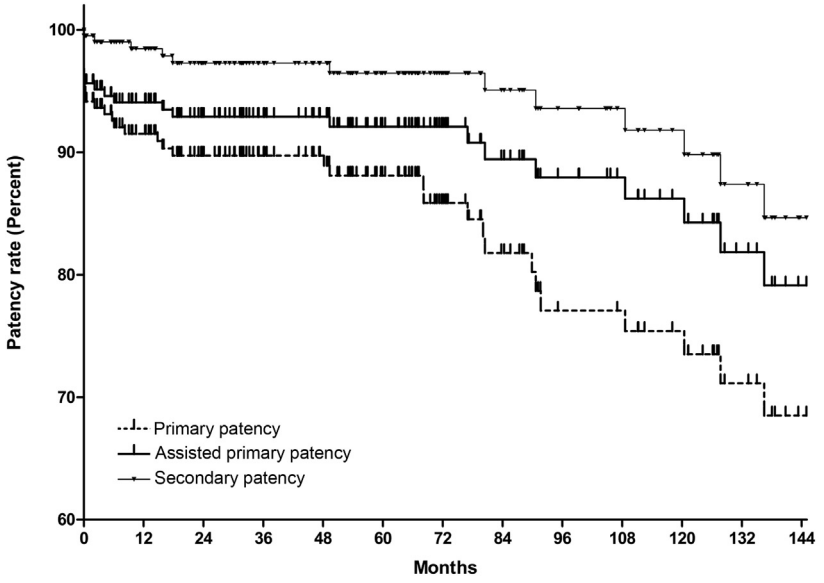
As a composite outcome parameter, we analyzed the freedom from any reintervention for patients having no secondary procedure or amputation (Fig 3) and were able to show a rate of 84.3% at 5 years and 69.8% at 10 years of follow-up with no significant difference between elective and emergent surgeries ($P = .0915$).

Duplex ultrasound follow-up examination revealed 12 (6%) popliteal aneurysms with continuing perfusion through collateral vessels (medial genicular artery). However, no aneurysm ruptures were noted and no secondary procedures had to be performed for perfused aneurysms. In addition, aneurysmal vein graft degeneration was noted in 19 grafts (9%), in six cases of relevant aneurysm formation (>20 mm), proximal graft replacement was performed (previously noted); in the remaining cases, aneurysmal degeneration was mild-moderate and was managed nonsurgically. For anticoagulation, most patients (n = 172; 84%) received oral anticoagulation (phenprocoumon; target international normalized ratio, 2.0), and 34 patients (16%) were given platelet aggregation inhibitors.

DISCUSSION

The results after open surgery for popliteal artery aneurysm have recently been reviewed and show a mean surgical mortality of 2%, a secondary patency of 81% at 3 years, and an amputation rate of 7% at 1 year and 4% at 3 years.[6] However, the mean number of surgeries per study was 75 and a Kaplan-Meier analysis of patency and limb salvage could not be performed because of the inhomogenicity of reported data. To date, the two largest single-center series are the studies by Huang et al[7] (n = 358) and Pulli et al[8] (n = 156) with primary, secondary patency, and limb salvage rates of 76%, 87%, 97% and 66%, 83%, 87% at 5 years, respectively, and an operative mortality of 1% and 2.1%, respectively.

Our results at 5 years with a primary and secondary patency and limb salvage rate of 88.1%, 96.5%, and 96.9% compare well with the above reports. In addition, we were able to provide robust follow-up data extending



Patency	Months	0	12	24	36	48	60	72	84	96	108	120	132	144
Primary	%	100	91.5	89.7	89.7	88.9	88.1	85.9	81.8	77.1	75.4	73.5	71.1	68.5
	No. at risk	206	164	141	121	110	91	70	58	48	46	40	30	22
	SEM		2.0	2.2	2.2	2.3	2.4	2.8	3.6	4.3	4.5	4.8	5.2	5.6
Assisted	%	100	94.1	92.9	92.9	92.9	92.1	92.1	89.4	87.9	86.2	84.3	81.9	79.1
	No. at risk	206	170	148	127	117	97	77	65	57	51	44	33	25
	SEM		1.7	1.8	1.8	1.8	2.0	2.0	2.7	3.0	3.4	3.9	4.4	5.1
Secondary	%	100	98.5	97.3	97.3	97.3	96.5	96.5	95.1	93.6	91.8	89.8	87.4	84.7
	No. at risk	206	178	155	132	121	101	80	68	60	53	46	36	25
	SEM		0.9	1.2	1.2	1.2	1.4	1.4	2	2.5	3	3.5	4.2	4.9

Fig 2. Kaplan-Meier analysis of overall primary, assisted primary patency, and secondary patency. In subgroup analysis no significant difference was found for primary patency, assisted primary patency, and secondary patency between the elective and the emergent group ($P = .1031$ for primary patency, $P = .2259$ for assisted primary patency, and $P = .2997$ for secondary patency). *SEM,* Standard error of the mean.

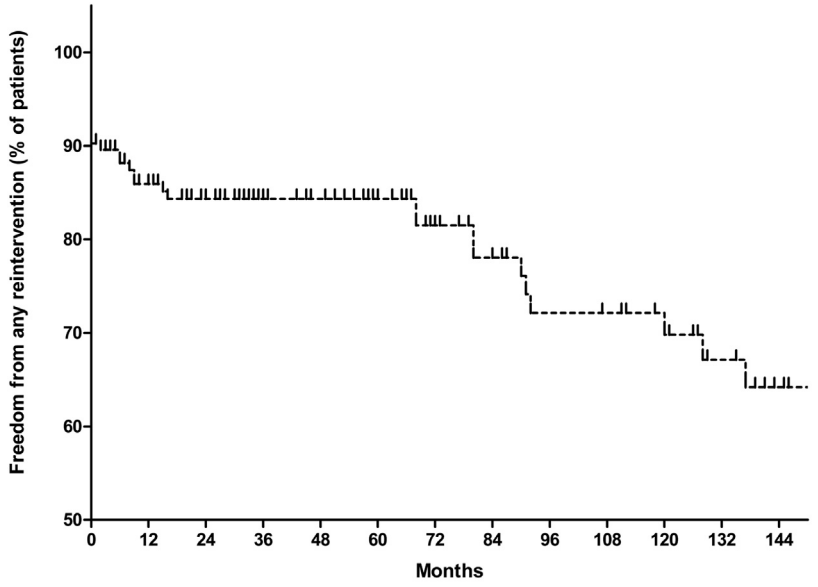
up to 10 years when an overall primary and secondary patency and a limb salvage rate of 73.5%, 89.8%, and 96.9% was observed. This is important, because none of the studies described herein provided limb salvage data beyond 5 years. In general, patency rates in this study of aneurysmal disease with a secondary patency of 96.5% and 89.8% at 5 and 10 years, respectively, for elective cases were excellent and superior to those commonly encountered in infrainguinal occlusive disease, a finding that has been well described and is attributed to expansive remodeling of the vein graft.[9] Cases of extensive remodeling leading to vein graft aneurysm formation have been observed in 9% in our series and in up to 42% in a series of 24 infrainguinal bypass grafts in patients with popliteal aneurysms and again are attributed to the systemic nature of the disease.[10]

We observed an inferior outcome in terms of limb salvage in patients who presented with acute ischemia: here, the early amputation rate was 9% in our series, which is slightly less than the amputation rate of 14.1% observed in a large meta-analysis of 895 cases.[11] However, with a limb salvage rate of 91.1% at 5 and 10 years, the results of emergent procedures for acute ischemia are significantly less than the limb salvage rate for elective cases (98.6% at 5 and 10 years), a finding also reported by other groups.[8,12,13] For graft patency, however, we did not observe a significant difference for elective vs emergent surgeries.

Endovascular treatment of popliteal artery aneurysms was first introduced in 1994 when an asymptomatic large aneurysm in a 63-year-old patient with advanced heart disease and multiple episodes of congestive heart failure was successfully excluded using insertion of a self-made device constructed of a polytetrafluoroethylene graft (6 mm) sutured to a balloon-expandable stent (Palmaz).[4]

In a literature survey, reported mortality and morbidity for endovascular therapy consistently are minimal, but patency rates show considerable variation of between 75% and 100% at 12 months.[2] Furthermore, follow-up time in general is short with only two reports proving robust long-term (5-year) data with secondary patency rates of 76% and 86%.[14,15]

Currently, the only available prospective randomized study that compared open and endovascular therapy compared groups of 15 patients each, and no statistical difference was noted for primary and secondary patency at 12 and 36 months, however, limitations of the study were reduced statistical power and short follow-up.[15]



FFRI	Months	0	12	24	36	48	60	72	84	96	108	120	132	144
	%	100	85.9	84.3	84.3	84.3	84.3	81.5	78.1	72.1	72.1	69.8	67.1	64.2
	No. at risk	154	112	99	84	80	67	55	44	37	36	31	25	20
	SEM		2.9	3.0	3.0	3.0	3.0	3.5	4.1	5.0	5.0	5.4	5.8	6.3

Fig 3. Kaplan-Meier analysis of freedom from any reintervention (*FFRI*). The percentage of patients with primarily patent grafts without any secondary intervention or amputation is given. In subgroup analysis, rates for FFRI were not significantly different for emergent vs elective surgeries ($P = .0915$). *SEM,* Standard error of the mean.

To further evaluate open and endovascular therapy, meta-analyses have been conducted, showing that open repair had clear advantages in terms of graft thrombosis and reintervention rate,[16] and graft patency at 1 and 3 years still was in favor of open repair.[17]

There is also consensus that further long-term follow-up is required to enable comparison of the two treatment modalities to determine the optimal management strategy.[18]

Reduced invasiveness is one of the key arguments in favor of endovascular therapy and most small studies report mortality rates of 0%.[2] However, there is a considerable span of 0% to 11% with a mean mortality of 0.4%,[6] and in the largest series on endovascular therapy of popliteal aneurysms, a perioperative mortality of 1.5% was encountered.[19] For open repair, mortality rates of 1%,[7] 1.6%,[12] and 2.1%[8] were observed in large single-center series and a recent meta-analysis stated a mean mortality of 2% (60/2838).[6] In our study, overall perioperative mortality was 2%, thus being comparable with the previously mentioned results. Of note, if the one patient who received surgery at the age of 89 years and with considerable cardiac comorbidity (coronary artery disease and coronary artery bypass grafting) were to be excluded, perioperative mortality would be 1% (1/120) for elective surgeries. For emergent surgeries, we noted a mortality of 3%, which is, however, not significantly different from the elective mortality and is in line with a large meta-analysis of acutely thrombosed aneurysms (3.2%).[11] With regard to perioperative morbidity, it has been stressed that open surgery is endowed with specific complications such as surgical site infections and hematoma.[20] In our series, the overall rate of hematoma was 8%, again being comparable with other studies.[19] The overall rate of fasciotomies was 5%, and was significantly greater in the emergent group (16%; $P = .0005$).

With regard to long-term performance, open surgery in our experience is a durable procedure with only a minor rate of secondary interventions, evidenced by an assisted primary patency of 92.1% and 84.3% at 5 and 10 years, respectively, comparable with other large studies.[7] The occurrence of late aneurysm perfusion warrants further discussion. In the literature, incidences show a wide range from high (33%-38%)[6,13] to intermediate (8%-15%),[12,21,22] down to very low incidences of 0%[23] and 3.2%.[7] It has been advocated that complementary endoaneurysmorraphy would be superior to simple ligation and bypass in preventing late recurrence,[7] but there are also reports of no recurrence after ligation and bypass.[23] In the Swedvasc study,[13] the inflow vessel had not been ligated in most cases of repeat surgery for aneurysm recurrence. In this regard, it has to be stressed, that varying techniques of ligation might be used and a simple ligation might allow perfusion of the aneurysm if not performed properly or if local atherosclerotic wall changes are present. Therefore, at our institution, we perform a double ligation with complete transsection of the artery and we observed a low rate of 5.8% for aneurysm recurrence/perfusion. Nonetheless, late aneurysm perfusion, which can be considered endoleak, is observed after endovascular therapy (7%) and open repair (9%).[6]

CONCLUSIONS

With our study, which represents to our knowledge, the second largest single-center series, and reports extended follow-up to 12 years, our results provide evidence that open surgical management of popliteal aneurysms is a durable procedure with low mortality and morbidity and excellent long-term patency (84.7% secondary patency at 12 years) and limb salvage (98.6% at 12 years for elective cases) which translates into a favorable rate of freedom from reintervention of 84.3% at five and 69.8% at 10 years. In the emergency setting of acutely thrombosed aneurysms with severe limb ischemia, significantly increased rates for amputation and fasciotomy were noted, and graft patency and survival were not influenced. Therefore, we join other authors in advocating open surgery as the current gold standard for management of popliteal aneurysms.[2,6,24] At our institution, based on our results, we predominantly perform open surgery for popliteal aneurysms but we also have applied endovascular therapy in a limited number of highly selected cases of patients considered unfit for open therapy. Therefore, the number of cases was too small to allow inclusion as a study group. Nonetheless, although it is believed that endovascular therapy is unlikely to displace open surgical therapy in the near future,[24] it surely does provide a viable alternative for selected patients with high surgical risk and carries promising potential for further device refinement. In addition, endovascular therapy carries potential for treatment in emergent situations, especially for ruptured aneurysms but possibly also in acutely thrombosed aneurysms because recanalization can be achieved rapidly using concomitant arterial lysis. Therefore, meticulous assessment of patient comorbidities and surgical risk evaluation is crucial to identify the subgroup of our patients that will benefit from the decreased invasiveness of endovascular therapy.

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AUTHOR CONTRIBUTIONS

Conception and design: BD, AG, CEK, CV
Analysis and interpretation: BD, AG, MD, AN, CEK, CV
Data collection: BD, AG, MD, AN, CEK CV
Writing the article: BD
Critical revision of the article: BD, AG, MD, AN, CEK, CV
Final approval of the article: BD, AG, MD, AN, CEK CV
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